IN THE SPECIFICATION:

Please replace paragraph [001] and the heading for paragraph [001] with the following amended paragraph:

~~PRIORITY CLAIM~~

~~[001]This application is a continuation-in-part of U.S. Patent Application No. 10/254,031, filed September 23, 2002, which claims priority based on U.S. Provisional Application No. 60/377,696, filed May 3, 2002, both of which are incorporated by reference into this document in their entirety.~~

Please replace paragraph [004] with the following amended paragraph:

[004] Surround sound systems generally use three or more loudspeakers (also referred to as "speakers") that reproduce sound from two or more discrete channels to create the surround effect. Successful development of the surround effect involves creating a sense of envelopment and spaciousness. Such a sense of envelopment and spaciousness, while very complex, generally depends on the ~~spacial~~ spatial properties of the background stream of the sound being reproduced. Reflective surfaces aid the sense of envelopment and spaciousness in the listening environment because reflective surfaces redirect impacting sound back towards the listener. The listener may perceive this redirected sound as originating from the reflective surface or surfaces, thus creating the perception that the sound is coming from all around the listener is enhanced.

Please replace paragraph [005] with the following amended paragraph:

[005] Many digital sound processing formats support direct encoding and playback of sounds using multi-channel surround processing systems. Some multi-channel surround processing systems have five or more channels, where each channel carries a signal for conversion into sound waves by one or more loudspeakers. Other channels, such as a separate band limited low frequency channel, also may be included. A common multi-channel surround processing format (referred to as a "5.1 system") uses five discrete channels and an additional

band limited low frequency channel that generally is reserved for low frequency effects ("LFE"). Recordings made for reproduction by 5.1 systems may be processed with the assumption that the listener is located at the center of an array of loudspeakers that includes three speakers in front of the listener and two speakers located somewhere between and including the sides of the listener and about 45 degrees behind the listener. In five channel multi-channel surround systems, both the channels and the signals carried by the channels may be referred to as left-front ("LF"), center ("CTR"), and right-front ("RF"), left-surround ("LSur"), and right-surround ("RSur"). When seven channels are implemented, LSur and RSur may be replaced by left-side ("LS"), right-side ("RS"), left-rear ("LR") and right-rear ("RR").~~.~~

Please replace paragraph [011] with the following amended paragraph:

[011] Sound processing systems have been developed that create a surround effect without the quality degradation experienced by known sound processing systems in non-optimum listening environments. These sound processing systems may include a matrix decoding system and/or a ~~base~~ bass management system. The matrix decoding system and the ~~base~~ bass management system enhance the surround effect in a complimentary manner~~s~~. The sound processing system may also include a signal source that may provide one or more digital signals to the matrix decoding system and/or the ~~base~~ bass management system, a post-processing module, and one or more electronic-to-sound wave transformers for converting one or more output signals into sound waves. The matrix decoding system and the ~~base~~ bass management system may be implemented in a sound processing system as part of a surround processing system. The surround processing systems may also include an adjustment module that may further adapt the system to a particular listening environment.

Please replace paragraph [014] with the following amended paragraph:

[014] ~~Base~~ Bass management systems generally create high frequency input signals for processing by a matrix decoder while preserving the low frequency components of the input signals in separate channels. By preserving the low frequency components of the input signals in separate channels, the surround effect created from the input signals may be enhanced. In

addition, the unnatural effects that may result from steered low frequency signals may be avoided by preventing the low frequency input signals from being processed by a matrix decoder.

Please replace paragraph [015] with the following amended paragraph:

[015] The ~~base~~ bass management systems may include a ~~base~~ bass management method that removes the low frequency component of the input signals to create high frequency input signals and, removes the low frequency components of the input signals to create high~~low~~ frequency input signals. The high frequency input signals may then be processed by a matrix decoding technique, while the low frequency input signals may forego such processing. In addition, the ~~base~~ bass management method may also include creating a separate low frequency or "SUB" signal and may include creating additional low frequency input signals. Further, the ~~base~~ bass management method may also include blending one or more of the low frequency input signals into one or more of the other low frequency input signals. This provides low frequency signals, for which there is no full-range speaker, an alternate path for reproduction. In addition, the ~~base~~ bass management methods may include combining the low frequency input signals with the high frequency input signals after they have been processed by a matrix decoding technique.

Please replace paragraph [016] with the following amended paragraph:

[016] The ~~base~~ bass management systems may include ~~base~~ bass management modules. These ~~base~~ bass management modules may include a low pass filter and a high pass filter for creating the high frequency input signals and the low frequency input signals, respectively. The ~~base~~ bass management modules may further include a summation device for creating a SUB signal as a combination of all the input signals. Alternately, the SUB signal may be defined by a LFE signal. The ~~base~~ bass management modules may further include additional summation devices for creating additional low frequency input signals. The ~~base~~ bass management modules may further include summation devices and may include a gain device for blending one or more of the low frequency input signals into one or more of the other low frequency input signals. In

addition, the ~~base~~ bass management module may be used in conjunction with a mixer, which recombines the low frequency input signals with the high frequency input signals after they have been processed by a matrix decoder module.

Please replace paragraph [017] with the following amended paragraph:

[017] The matrix decoding systems and/or the ~~base~~ bass management systems may be implemented in sound processing systems designed for specific non-optimum listening environments. One example includes vehicular listening environments. These "vehicular sound systems" may include a signal source, a surround processing system, a post-processing module, and a plurality of speakers located throughout a vehicle. The components of the vehicular sound systems may be adapted for a specific vehicle or type of vehicle so that the surround effect is enhanced throughout the vehicle. The surround processing system may include a matrix decoding module, a bass management module, a mixer, or a combination. The vehicular sound systems may also be implemented in larger vehicles. In such an implementation, the vehicular sound systems may include additional speakers, such as: additional center and side speakers that reproduce additional center and side output signals, respectively, produced by the surround processing system.

Please replace paragraph [041] with the following amended paragraph:

[041] Alternatively, the matrix decoder module 120 may be coupled to the bass management module 110 from which it receives the high frequency input signals and creates a greater or equal number of high frequency output signal. For example, if the matrix decoder module 120 includes a N X 7 matrix decoder and is coupled to a ~~base~~ bass management module 110 from which it receives LFI_H and RFI_H (and may additionally receive $CTRI_H$, $LSurI_H$, and $RSurI_H$), the matrix decoder module 120 will produce seven high frequency output signals, including: a high frequency left-front output signal ("LFO_H"), a high frequency right-front output signal ("RFO_H"), a high frequency center output signal ("$CTRO_H$"), a high frequency left-side output signal ("LSO_H"), a high frequency right-side output signal ("RSO_H"), a high frequency left-rear output signal ("LRO_H"), and a high frequency right-rear output signal ("RRO_H"). In

another example, if the matrix decoder includes an N X 11 matrix decoder and is coupled to a signal source 101 from which it receives LFI and RFI (and may additionally receive CTRI, LSurI, and RSurI), in addition to the output signals mentioned above, it may further produce a second high frequency center output signal ("$CTRO2_H$"), a third high frequency center output signal ("$CTRO3_H$"), a second high frequency left-side output signal ("$LSO2_H$"), and a second high frequency right-side output signal ("$RSO2_H$").

Please replace paragraph [044] with the following amended paragraph:

[044] The post-processing module 104 may receive the adjusted output signals from the adjustment module 180 and the SUB signal from either the bass management module 110 or the signal source 101. The post-processing module 104 generally prepares the signals it receives for conversion into sound waves and may include one or more amplifiers and one or more digital-to-analog converters. The electronic-to-sound wave transformer 106~~,~~ may receive signals directly from the post-processing module or indirectly through other devices or modules such as crossover filters (not shown). The electronic-to-sound wave converter 106 generally includes speakers, headphones or other devices that convert electronic signals into sound waves. When speakers are used, at least one speaker may be provided for each channel, where each speaker may include one or more speaker drivers such as a tweeter and a woofer.

Please replace paragraph [047] with the following amended paragraph:

[047] One example of a method by which the low and high frequency input channels may be created (a "bass management method") is shown in FIG. 2. While a particular configuration is shown, other configurations may be used including those with fewer or additional steps. This ~~base~~ bass management method 210 generally includes: removing the low frequency component from the input signal to create high frequency input signals 212, removing the high frequency component from the input signals to create initial low frequency input signals 214, creating low frequency input signals 215, and creating a SUB signal 216. Additionally, if the input signals include any surround signals, the bass management method 210, may include creating low frequency side input signals. The ~~base~~ bass management method may further

include combining the low frequency input signals and, in some cases, the SUB signal with the high frequency input signals after the high frequency input signals have been processed by a matrix decoder (the high frequency output signals).

Please replace paragraph [052] with the following amended paragraph:

[052] The ~~base~~ bass management method 210 may further include combining the low frequency input signals and the SUB signal with the high-frequency output signals created by a matrix module (see FIG. 1, reference number 120). For example, if the ~~base~~ bass management method receives a 2-channel input signal (including, for example, LFI and LRI) from which it creates LFI_L and RFI_L, these low frequency input signals may be combined with the high-frequency output signals produced by a 2 X 7 matrix decoder to create full-spectrum high frequency output signals according to the following equations:

$$LFO = LFO_H + LFI_L \tag{3}$$
$$RFO = RFO_H + RFI_L \tag{4}$$
$$CTRO = CTRO_H + SUB \tag{5}$$
$$LSO = LSO_H + LFI_L \tag{6}$$
$$RSO = RSO_H + RFI_L \tag{7}$$
$$LRO = LRO_H + LFI_L \tag{8}$$
$$RRO = RRO_H + RFI_L \tag{9}$$

Please replace paragraph [053] with the following amended paragraph:

[053] In another example, if the ~~base~~ bass management method receives a 5.1 discrete input signal (including input signals, such as, LFI, RFI, CTRI, LSurI, and RSurI) from which it creates LFI_L, RFI_L, $CTRI_L$, LSI_L, RSI_L, LRI_L, and RRI_L, these low frequency input signals may be combined with the high frequency output signals produced by a 5 X 7 matrix decoder to create full-spectrum output signals according to the following equations:

$$LFO = LFO_H + LFI_L \quad (10)$$

$$RFO = RFO_H + RFI_L \quad (11)$$

$$CTRO = CTRO_H + CTRO_L \quad (12)$$

$$LSO = LSO_H + LSI_L \quad (13)$$

$$RSO = RSO_H + RSI_L \quad (14)$$

$$LRO = LRO_H + LRI_L \quad (15)$$

$$RRO = RRO_H + RRI_L \quad (16)$$

Please replace paragraph [054] with the following amended paragraph:

[054] In another example, if the ~~base~~ bass management method receives a 5.1 discrete input signal (including, input signals such as, LFI, RFI, CTRI, LSurI, RSurI) from which it creates LFI_L, RFI_L, $CTRI_L$, LSI_L, RSI_L, LRI_L, and RRI_L, these low frequency input signals may be combined with the output signals produced by a 5 X 11 matrix decoder to create full-spectrum output signals according to equations (10) through (16) and additional full-spectrum output signals, including a second center ("CTRI2"), a third center ("CTRO3"), a second left~~right~~-side ("LSO2"), and a second right-side ("RSO2") output signal according to the following equations:

$$CTRO2 = CTRO_H + CTRO_L \quad (17)$$

$$CTRO3 = CTRO_H + CTRO_L \quad (18)$$

$$LSO2 = LSO2_H + LSI_L \quad (19)$$

$$RSO2 = RSO_H + RSI_L \quad (20)$$

This bass management method may be extended to create further additional full-spectrum side and center output signals by adding any additional high frequency side output signals with the corresponding low frequency surround signal.

Please replace paragraph [055] with the following amended paragraph:

[055] The bass management method may be implemented in a ~~base~~ bass management module, such as that shown in FIG. 1 (reference number 110). The ~~base~~ bass management

module 110 may include a high frequency filter that removes the low frequency component from the input signal to create high frequency input signals, and a low frequency filter that removes the high frequency component from the input signals to create initial low frequency input signals. Additionally, the ~~base~~ bass management module 110 may define the SUB signal by an LFE signal or may include a summation device for creating a SUB signal. Further, if the input signals include any surround signals, the bass management module 110, may include one or more summation devices for creating low frequency side input signals. The ~~base~~ bass management module 110 may also include one or more summation devices for blending one or more undesired initial low frequency input signals into other initial low frequency input signals.

Please replace paragraph [061] with the following amended paragraph:

[061] The matrix decoder module 120 shown in FIG. 1 may include any matrix decoding method that converts a number of discrete input signals into a greater or equal number of output signals. For example, the matrix decoder module 120 may include methods for decoding a two-channel input signal ~~in to~~into 7 output signals, such as those used by Logic7® or DOLBY PRO LOGIC®. Alternately the matrix decoder module 120 may include a matrix decoding method that decodes discrete multi-channel signals in a manner suitable for non-optimum listening environments (a "multi-channel matrix decoding method"). The matrix decoders and matrix decoding methods may receive full-spectrum input signals or low frequency input signals. In the example description associated with this section (Matrix Decoding Systems) including FIGs 7 and 8 with regard to matrix decoder modules, matrix decoders and matrix decoding methods, any reference to any input signal, output signal, initial output signal, or combinations will be understood to refer to both full-spectrum and low frequency input and output signals, unless otherwise indicated.

Please replace paragraph [063] with the following amended paragraph:

[063] An example of a multi-channel matrix decoding method is shown in FIG. 5 and indicated by reference number 530. While a particular configuration is shown, other configurations may be used including those with fewer or additional steps. This multi-channel

matrix decoding method 530 generally includes: creating input signal pairs 532, and creating output signals as a function of the input signal pairs 534. Input signal pairs are created 532 as a combination of the various input signals. When used as the input signals for matrix decoding techniques, the input signal pairs enable the output signals to include a different combination of input signals which, if the output signals were defined solely by the matrix, would not have been included. Therefore, the surround effect is enhanced even in non-optimum listening environments. For example, an input signal pair may be created so that the rear output signals resulting from a matrix decoding technique are a function of all the input signals. As a result, some sound will emanate from the rear of the listening environment whenever there is an input signal, which enhances the surround effect in listening environments that lack adequate reverberation. The input signal pairs may be created so that certain input signals or an amount of certain input signals are blended with adjacent input signals to provide a smoother transition between adjacent channels. In addition, the input signal pairs may be a function of one or more tuning parameters, which can be adjusted to control the amount of a certain input signal included in an output signal. The result is a smoother auditory transition between adjacent channels, which helps compensate for non-optimum speaker and listener placement within a listening environment. Furthermore, input signal pairs may also be created so that the output signal is steered based on ~~spacial~~ spatial clues from all the input signals and not just those included in the front input signals.

Please replace paragraph [068] with the following amended paragraph:

[068] In addition, an input signal pair may be created for use by known matrix decoding techniques determining one or more steering angles (the "steering angle input pair" or "SAIP"). In known matrix decoding techniques, one or more steering angles are determined using the left and right input signals. However, when there are more than two input signals, it may be advantageous to "steer" the output signals according to directional changes in all the input signals. Such may be accomplished without altering the method used for ~~determing~~ determining the steering angle by determining the steering angles from input signal pairs that are a function of all the input signals. For example, when converting five discrete input signals into seven outputs, the steering angle input pair may be defined according to the following equations:

$$SAI1 = LFI + 0.7CTRI + 0.91LSurI + 0.38RSurI \quad (27)$$

$$SAI2 = RFI + 0.7CTRI - 0.38LSurI - 0.91RSurI \quad (28)$$

where SAI1 the is first signal of the steering angle input pair (the "first steering angle input signal"), and SAI2 is the second signal of the steering angle input pair (the "second steering angle input signal").

Please replace paragraph [087] with the following amended paragraph:

[087] An example of a mixer that may be used to combine the high frequency output signals created by a 5 X 11 matrix decoder with the low frequency input signals created by a bass management module is shown in FIG. 11. The mixer 1170 generally includes several summation modules 1171, 1172, 1173, 1174, 1175, 1176, 1177, 1178, 1179, 1180 and 1181, <u>which combine</u> the high frequency output signals created by a 5 X 11 matrix decoder (LFO_H, RFO_H, $CTRO_H$, $CTRO2_H$, $CTRO3_H$, LSO_H, $LSO2_H$, RSO_H, $RSO2_H$, LRO_H and RRO_H) with the low frequency input signals (LFI_L, RFI_L, $CTRI_L$, LSI_L, RSI_L, LRI_L, and RRI_L) created by a bass management module to produce full-spectrum output signals LFO, RFO, CTRO, LSO, RSO, LRO, RRO, CTRO2, CTRO3, LSO2, and RSO2 according to equations (10) through (20) respectively. This mixer 1170 may be extended to create additional full-spectrum side output signals by including additional summation modules to add any additional high frequency side output signals to the corresponding low frequency surround signals. Alternately, if the low frequency input signals created by a bass management module include additional low frequency side input signals, such as: $LSI2_L$ and $RSI2_L$, these additional low frequency side input signals may be added to the corresponding additional high frequency output signals, such as $LSO2_H$ and $RSO2_H$, respectively.

Please replace paragraph [088] with the following amended paragraph:

[088] It is often advantageous to be able to customize the sound waves produced by a sound processing system, such as that shown in FIG. 1, for a particular listening environment.

Therefore, the sound processing system 100 may include an adjustment module 180. The adjustment module 180, may receive full-spectrum output signals from the matrix decoder module 120, or the mixer 160, or high frequency output signals from the matrix decoder module 120 and low frequency input signals from the bass management module_110. From the signals it receives, the adjustment module 180 produces signals that have been adjusted for a particular listening environment (the adjusted output signals). Additionally, the adjustment module 180 may create additional adjusted output signals. For example, when five output signals are being produced, the adjusted output signals include an adjusted left-front output signal LFO', an adjusted right-front output signal RFO', an adjusted center output signal CTRO', an adjusted left-rear output signal LRO', and adjusted left-side output signal LSO', and adjusted right-rear output signal RRO' and an adjusted right-side output signal RSO'. When eleven output signals are being produced, the seven prior mentioned adjusted output signals are produced along with a second adjusted center output signal CTRO2', a third adjusted center output signal CTRO3', a second adjusted left-side output LSO2' and a second adjusted right-side output RSO2'.

Please replace paragraph [091] with the following amended paragraph:

[091] The sound processing system 100 of FIG. 1 may also operate in an alternate mode in which the matrix decoder module 120 is disengaged. In this case, the bass management module 110 and the mixer 160, if included, may also be disengaged. When the sound processing system 100 operates in this alternate mode, the adjustment module 180 may also operate in an alternate mode to create additional adjusted output signals to replace those that would have been created by the disengaged matrix decoder module 120. A block diagram of an adjustment module designed to tune seven signals operating in this additional mode is shown in FIG. 13. While a particular configuration is shown, other configurations may be used including those with fewer or additional components. The adjustment module in an alternate mode 1390 generally creates two additional output signals from five discrete input signals and may include a gain module 1392, an equalizer module 1394, and a delay module 1396, where each may contain the same number of gain units, equalizer units and delay units as it did in the non-alternate mode. However, in the alternate mode, some of the signals received by the adjustment module 1392 may be coupled to more than one gain unit. The gain module 1392 may include seven gain units

1380, 1381, 1382, 1383, 1384, 1385, and ~~1392g~~1386. Gain units 1380, 1381, 1382, 1383 and 1385 may each receive a separate discrete input signal LFI, RFI, CTRI, LSurI and RSurI, respectively, and may couple the signals to separate equalizer units (not shown) within the equalizer module 1394. The signals may then be coupled to separate delay units (not shown) within the delay module 1396 to create adjusted output signals LFI′, RFI′, CTRI′, LSurI′ and RsurI′. However, gain unit 1384 also receives LSurI, which it may couple to a separate equalizer unit (not shown) within the equalizer module 1394. LSurI may then be coupled to a separate delay unit (not shown) within the delay module 1396 to create an additional adjusted output signal $LsurI'_2$. Similarly, gain unit 1386 receives RSurI, which it may coupled to a separate equalizer unit (not shown) within the equalizer module 1394. RSurI may then be coupled to a separate delay unit (not shown) within the delay module 1396 to create an additional adjusted output signal $RsurI'_2$.

Please replace paragraph [092] with the following amended paragraph:

[092] A block diagram of an adjustment module designed to tune eleven signals that is operating in an alternate mode is shown in FIG. 14 and indicated by reference number 1490. While a particular configuration is shown, other configurations may be used including those with fewer or additional components. The adjustment module in an alternate mode 490 may create six additional output signals from five discrete input signals and may include a gain module 1492, an equalizer module 1494, and a delay module 1496, where each may contain the same number of gain units, equalizer units and delay units as it did in the non-alternate mode. However, in the alternate mode, some of the signals received by the adjustment module 1492 may be coupled to more than one gain unit. The gain module 1492 may include eleven gain units 1470, 1471, 1472, 1473, 1474, 1475, 1476, 1477, 1478, 1479 and 1480. Gain units 1470, 1471, 1472, 1475 and 1478 may each receive a separate discrete input signal LFI, RFI, CTRI, LSurI and RSurI, respectively, and couple the signals to separate equalizer units (not shown) within the equalizer module 1494. The signals may then be coupled to separate delay units (not shown) within the delay module 1496 to create adjusted output signals LFI′, RFI′, CTRI′, LSurI′ and RsurI′. However, gain units 1473 and 1474 may also receive CTRI, which each may be coupled ~~couple~~ to separate equalizer units (not shown) within the equalizer module 1494. The

signals may then be coupled to separate delay units (not shown) within the delay module 1496 to create additional adjusted center output signals $CTRI_2'$ and $CTRI_3'$. Similarly, gain units 1476 and 1477 may each receive LSurI, which each may ~~couple~~ be coupled to a separate equalizer unit (not shown) within the equalizer module 1494. The signals may then be coupled to a separate delay unit (not shown) within the delay module 1496 to create additional adjusted left-side output signals $LsurI_2'$ and $LsurI_3'$. Similarly, gain units 1479 and 1480 may each receive RSurI, which each may ~~couple~~ be coupled to a separate equalizer unit (not shown) within the equalizer module 1494. The signals may then be coupled to a separate delay unit (not shown) within the delay module 1496 to create an additional adjusted output signal RsurI′.